MONTHLY WEATHER REVIEW.

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BOARD OF EDITORS { Mr. Horace E. Smith, Chief Clerk Weather Bureau, Professors Henry A. Hazen, Thomas Russell, and Charles F. Marvin, and Mr. Edward B. Garriott, in charge of Review Room.

INTRODUCTION.

This REVIEW is based on reports for November, 1891, from 2,630 regular and voluntary observers. These reports are classified as follows: 159 reports from Weather Bureau stations; 118 reports from United States Army post surgeons; 1,684 monthly reports from state weather service and voluntary observers; 34 reports from Canadian stations; 214 reports through the Central Pacific Railway Company; 421 marine reports through the co-operation of the Hydrographic Office, Navy Department; marine reports through the "New York Herald Weather Service;" monthly reports from local weather services established in all states and territories, except Idaho, and international simultaneous observations. Trustworthy newspaper extracts and special reports have also been used.

CHARACTERISTICS OF THE WEATHER FOR NOVEMBER, 1891.

The month was warmer than usual west of the Rocky Mountains and over the extreme northeastern part of the country, and was colder than the average November in the central valleys and along the Atlantic coast south of the 43d parallel. Over the west part of the middle plateau region and in Oregon the mean temperature was more than 4° above the normal, and in the upper Mississippi and middle Missouri valleys the deficiency exceeded 6°. At a number of stations in the plateau region and on the Pacific coast the month was the warmest November on record. The highest temperature ever reported for November was noted generally from the eastern slope of the Rocky Mountains to the Pacific coast during the first decade of the month. A well-defined cold wave advanced from the Pacific to the Atlantic coasts from the 16th to 18th, with heavy frost to the middle and east Gulf coasts and northern Florida, and a cold wave, which was attended at several stations by the lowest temperature on record for November, extended from Manitoba to the Atlantic coast from the 28th to 30th.

PRECIPITATION.

The monthly precipitation was in excess of the November average from the central lake region to the middle Gulf coast, and from the Red River of the North Valley to the north Pacific coast. In the Atlantic coast states, and over the southwestern and middle-western districts the monthly precipitation was deficient. The greatest excess occurred on the north Pacific coast, where it varied from 5 to 10 inches, and the most marked deficiency was noted over eastern Nova Scotia, where it exceeded 4 inches. At stations on the north Pacific coast, in the upper Missouri valley, from the central lake region over the upper Ohio valley, and in northern Arkansas and western Florida the monthly precipitation was the greatest, and at points west of the lower Missouri and lower Mississippi valleys it was the least ever noted for November. The monthly snowfall exceeded 60 inches at Climax, Colo.; 30 inches in extreme northern upper Michigan; 20 inches in northeastern southern Idaho and northern Wyoming; and 10 inches in northern New York, the interior of Virginia and North Carolina, northern Indiana, western and southern lower Michigan, and in parts of the Dakotas and western Minnesota. At the close of the month snow was reported on the ground in the interior of the Atlantic coast states from South Carolina northward, in the Lake region and the north part of the Ohio valley, and from the east part of the middle plateau region to the upper Mississippi and Red River of the North valleys.

STORMS.

Heavy wind and rain storms prevailed on the north Pacific coast during the first decade of the month. Heavy gales, with snow, occurred from Nebraska and the Dakotas over the Lake region on the 11th; heavy gales over the Lake region on the 16th and 17th; over the middle Atlantic and New England states on the 17th; over Lake Huron and Saginaw Bay on the 19th; over the Lakes on the 21st; and in the east Gulf states on the 22d. Storms of exceptional severity occurred over the middle Atlantic states and lower lake region on the 23d, resulting in loss of life and property. On the 26th heavy gales were reported over Lake Huron and Saginaw Bay; and on the 29th high winds prevailed along the Virginia and North Carolina coasts.

INLAND NAVIGATION.

By the close of the month the rivers in the northern tier of states were generally frozen over, and navigation was closed for the season. Navigation was reported closed for the season in the canals of New York, except the Erie, on the 30th.

DROUGHT.

Drought continued during the month in western Texas, Arizona, southern Kansas, and western Missouri. The drought in parts of New England and eastern New York, and in sections of the south Atlantic and Gulf states, Tennessee, Indian Territory, and the lower Ohio valley was broken during the first and second decades of the month.

ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure for November, 1891, as determined from observations taken daily at 8 a. m. and 8 p. m. (75th meridian time), is shown on Chart II by isobars.

In November the mean pressure is usually highest over the middle plateau region, where it rises above 30.20; it is above 30.15 over the interior of the middle and east Gulf and south Atlantic states. The normal pressure for November is lowest over the Gulf of Saint Lawrence and Newfoundland, where it falls below 30.00. There is usually an increase of pressure over the United States and Canada, except from the lower lake region over the Canadian Maritime Provinces; there is also an increase of pressure over the north Atlantic Ocean south of the 40th parallel and west of the 40th meridian. Over the central part of the middle plateau region the normal pressure for November is more than .10 higher than for October, and from the lower lake region over Newfoundland the decrease exceeds .05.

In November, 1891, the mean pressure was above 30.20 over the Carolinas and Virginia, and in an area extending from Oregon over the middle plateau region the mean values were above 30.15. The mean pressure was lowest over Canada and the British Northwest Territory, where it was below 30.00.

A comparison of the pressure chart for November, 1891, with that of the preceding month shows an increase of mean pressure over the Atlantic coast states, the Dakotas and Minnesota, the Pacific coast states and the west part of the plateau region; elsewhere there was a decrease of pressure. The most marked increase of pressure occurred along the immediate Atlantic coast north of the 35th parallel, and over the central valleys of California, where it was .10, or more, and the greatest decrease was noted over the north-central part of the Lake region, and in an area extending from Missouri to central Texas, where it exceeded .05.

The mean pressure was above the normal east of the Mississippi River, along the Pacific coast, and over western Nevada. From the Rio Grande Valley and Arizona northward to the British Possessions, and over the north part of the Lake region, the mean pressure was below the normal. The greatest departure above the normal occurred along the New England and Nova Scotia coasts, where it exceeded .10, and the most marked departure below the normal was noted from New Mexico to Montana, and in Manitoba, where it varied from .05 to .10.

HIGH AND LOW AREAS.

The paths of well-defined areas of high and low pressure for November, 1891, are shown on Charts IV and I, respectively, and some of the more prominent features of the areas are noted in the table at the end of this chapter.

HIGH AREAS.

Eight high areas appeared, the average number traced for November during the last 16 years being 7. Four of the high areas apparently advanced from the Pacific Ocean, and 2 from the British Northwest Territory; one appeared over the middle plateau region, and one was a continuation of high area X for October, 1891. Two of the Pacific high areas, V and VI, traversed the continent, the average rate of progress being 24 and 27 miles per hour, respectively, and 2 disappeared by a decrease of pressure, one over the southern plateau, and the other over the middle Missouri valley. One of the high areas from the British Northwest Territory reached the Gulf of Saint Lawrence, and the other disappeared by a decrease of pressure over the middle and south Atlantic states. The high area which appeared over the middle plateau disappeared by a decrease of pressure over the southern plateau region, and the continuation of high area X for October, which was central over the north-central part of the country at the opening of the month, advanced to the Gulf of Saint Lawrence. The high areas followed a southeasterly course to the Mississippi River and passed thence east or north of east to the Atlantic coast, the average rate of advance, 24 miles per hour, being somewhat less than the average velocity of high areas for November. The following is a description of the high areas traced:

I.—Was a continuation of high area X traced for October, 1891, and at the opening of the month occupied the north-central part of the country, with pressure above 30.50 and freezing weather in an area extending from the Saskatchewan Valley over the middle Missouri valley. During the 2d and 3d this area moved over the south part of the Lake region, with a marked decrease of pressure on the latter-named date, and the morning of the 3d the temperature was below freezing in the middle and upper Ohio valleys, West Virginia, and central and western Virginia. During the 4th the center advanced to the Canadian Maritime Provinces, and the line of freezing weather extended to southern Pennsylvania.

II.—Appeared over the middle plateau region the evening of the 3d, with pressure above 30.20, and moving thence slowly southeastward disappeared by a decrease of pressure over the southern plateau region during the 5th, its passage being unattended by noteworthy features.

III.—Apparently advanced from the British Northwest Territory, and the morning of the 4th was central over Assiniboia, whence it moved to Minnesota by the morning of the 5th, and passed thence rapidly eastward to the Gulf of Saint Lawrence by the evening of the 6th, its rate of advance, 34 miles per hour, being the most rapid noted in connection with the high areas of the month. The influence of this area was small; the highest pressure noted attending its passage was 30.30, at Rockliffe, Ont., the morning of the 6th; and the line of freezing weather extended over Minnesota and the east part of the Dakotas on the 5th, and over western New York and the greater part of New England on the 6th. On the 7th this high area was central over the Gulf of Saint Lawrence and a ridge of high pressure extended thence to the Carolinas, where a second center of high pressure appeared; a cyclonic area of considerable strength was central off the middle Atlantic coast; and strong northerly winds prevailed along the New England and middle Atlantic coasts. Attending these conditions there was an abnormal fall in temperature of 5° to 11° in 12 hours over the south Atlantic states, and the first heavy frost of the season was noted at points on the southern coast of North Carolina.

IV.—Advanced from the Pacific Ocean and the evening of the 7th was central over Oregon, whence it moved slowly southeastward and disappeared by a decrease of pressure over the southern plateau region during the 9th. The pressure rose to 30.50 over the middle plateau region on the 8th, after which there was a marked decrease of pressure. On the 9th the first heavy frost of the season was noted at points in southeastern Arizona and extreme western Texas, and on the 10th at stations in eastern Texas south of the 30th parallel, and in Oklahoma Territory.

V.—Appeared off the Oregon and northern California coasts on the 9th, moved thence to the British Northwest Territory by the night of the 10th, thence to the upper Mississippi valley by the 13th, and thence to the New England coast by the night of the 15th. During the night of the 9–10th the abnormal rise in pressure in 12 hours was .80 inch over Alberta, and the pressure rose above 30.60 over Alberta by the evening of the 10th, with an abnormal temperature fall of more than 30° in Montana, and snow at points in western Montana and the British Northwest Territory. On the 11th the temperature was below zero in Alberta and the line of freezing weather extended over Colorado and Kansas. On the 12th a ridge of high pressure extended from the British Northwest Territory to Texas, the minimum temperature was below zero in central Montana, the line of freezing weather extended to Oklahoma Territory, and the first heavy frost of the season was noted at stations in central and eastern Texas. The morning of the 13th an elongated area of high pressure extended from the lower Ohio valley northwestward to the British Possessions, with central pressure ranging from 30.40 to 30.50, freezing weather occurred in the west part of the Lake region, the lower Ohio and upper Mississippi valleys, and heavy frost in the interior of the Gulf States and Georgia. On the 14th there was a slight increase in pressure, and the line of freezing weather extended to Virginia. On the morning of the 15th this area was central in the Saint Lawrence Valley,

where the pressure rose to 30.70 at Montreal, Quebec, in the morning, whence it moved eastward and was located off the Nova Scotia coast the morning of the 16th, with pressure above 30.70.

VI.—This high area was attended by a well-marked cold wave from the Pacific to the Atlantic coasts, and throughout the greater part of its course was attended by the lowest temperature of the month. It first appeared on the north Pacific coast on the 14th, with pressure above 30.30 in northwest Washington, freezing weather in the plateau region to northern New Mexico, the lowest temperature of the month at Fresno City, Cal., and Fort Canby, Wash., and the first heavy frost of the season at Port Angeles, Wash., and at points in northern California. On the 15th the pressure rose above 30.50 in Alberta, the line of freezing weather extended from the Lake region to northern New Mexico, the minimum temperature fell to zero at Lander, Wyo., the temperature was the lowest noted for the month in the west part of the middle and southern plateau regions, and the first heavy frost of the season occurred at points in the Sacramento Valley, California. During the 16th the center of this high area moved southeastward along the eastern slope of the Rocky Mountains, with pressure above 30.70, and a very marked barometric gradient to the eastward. The minimum temperature was below zero in Montana, Wyoming, and North Dakota, and a reading of —15° was recorded at Lander, Wyo. Over the greater part of the middle and northern plateau regions, on the north Pacific coast, and over the northeast slope of the Rocky Mountains the temperature was the lowest noted for the month, and the first heavy frost of the season was reported in western Oregon, southwestern Washington, and at points in southeastern Arizona. Continuing a southeasterly course the area reached the middle Mississippi valley the morning of the 18th. On the 17th the pressure rose to 30.80 in Kansas, the minimum temperature was below zero in Nebraska, a reading of —18° being reported at Valentine, freezing weather extended over the west Gulf states nearly to the coast line, the lowest temperature of the month was reported generally from the Dakotas to Texas, and the first heavy frost of the season was reported at Palestine, Tex. During the 18th the center passed eastward to West Virginia, with pressure ranging from 30.70 to 30.80, freezing weather occurred over the Gulf and south Atlantic states, the lowest temperature of the month at points from the Ohio Valley to the north part of the east Gulf states, and the first heavy frost of the season at stations on the immediate east Gulf and south Atlantic coasts and in northern Florida. During the 19th the high area passed off the middle Atlantic coast, with a slight increase of pressure.

VII.—Apparently advanced from the Pacific Ocean, and the morning of the 21st was central over Alberta, with pressure above 30.40. On this date the greatest abnormal rise in pressure in 12 hours noted for the month, .88, occurred at Medicine Hat, Assiniboia; and at Pueblo, Colo., there was an abnormal fall in temperature of 36° in 12 hours. Moving southeastward this high area disappeared by a decrease of pressure over the middle Missouri valley the night of the 22d.

VIII.—This high area was attended by a well-defined and unusually severe cold wave, and the lowest temperature of the month generally east of the 95th meridian, and in the middle Missouri and Red River of the North valleys. This cold wave advanced from Minnesota to the Atlantic coast from the 28th to the 30th. The high area apparently advanced from the British Northwest Territory, and the evening of the 27th was central over North Dakota, with pressure above 30.30, and temperature below zero southward to eastern South Dakota. By the morning of the 28th the center of the area had shifted slightly southeastward, the pressure had risen above 30.50, the minimum temperature fell below zero over Iowa, and was below —20° in the Valley of the Red River of the North, the line of freezing weather extended over the Ohio Valley, and the lowest temperature of the month was noted in the middle Missouri and Red River of the North valleys. The morning of the 29th an elongated area of high pressure extended from Wisconsin to Texas, with pressure above 30.60, the minimum temperature fell to zero along the Mississippi River as far south as Keokuk, Iowa, the line of freezing weather extended over the interior of the Gulf and south Atlantic states, the lowest temperature of the month occurred in the middle and upper Mississippi valleys, and the lowest temperature ever reported for November was noted at Des Moines, Iowa. During the 30th the high area contracted and there was a decrease of about .10 in central pressure. The center moved eastward over Tennessee, and was central over extreme western Virginia at the time of the last report of the month. On this date the line of freezing weather extended to the immediate east Gulf and south Atlantic coasts, the lowest temperature of the month was noted generally along the east Gulf and Atlantic coasts, the lowest temperature ever reported for November was recorded at Vicksburg, Miss., New Orleans, La., and Hatteras, N. C., and the first heavy frost of the season occurred at New Orleans, La., and Charleston, S. C.

LOW AREAS.

The principal track of November low areas over the North American continent lies between the 45th and 50th parallels, somewhat to the southward of the principal track for October; less frequented tracks are traced from the British Northwest Territory, the middle plateau region, and Texas, and unite with the main track over eastern Ontario; and well-defined storms, averaging about two per year, advance northward from the vicinity of Bermuda. The region of greatest storm frequency in November embraces Canada east of the 80th meridian, where the average number of low areas exceeds 5. Individual low areas seldom traverse the continent in November, the average number traced from the Pacific to the Atlantic oceans for that month being 0.6. The average velocity of the low areas, which is about 25 miles per hour during the summer, increases to 31 miles per hour in November.

The tracks of 13 low areas are plotted on Chart I for November, 1891, the average number traced for the corresponding month of the last 16 years being 12. Of the low areas traced for the current month 5 advanced from the north Pacific Ocean, one of which reached the Atlantic coast; 4 first appeared in the British Northwest Territory; 5 apparently originated on the southeast slope of the Rocky Mountains, two of which were subsidiary developments; and one was a continuation of low area X for October, 1891. The tracks of the low areas converged toward the Great Lakes and the Saint Lawrence Valley, and the average rate of progress, 31 miles per hour, was the same as the average velocity of November low areas of preceding years. Low area X, which advanced from Indian Territory to the lower Saint Lawrence valley from the 21st to 24th, was notably severe, and a description of its more prominent features is given herein. Low areas off the Atlantic coast caused high winds from New England to the Carolinas during the first decade of the month, and along the North Carolina coast during the 29th and 30th. The following is a description of the low areas which appeared over the United States and Canada:

I.—Was a continuation of low area X for October, and passed eastward from the lower Saint Lawrence valley to the Gulf of Saint Lawrence on the 1st, with pressure below 29.40, winds of 30 miles per hour and upwards from the Lake region to the New England and Nova Scotia coasts, and rain changing to snow in the lower Saint Lawrence valley. On this date the highest temperature of the month was noted generally in the south Atlantic states.

II.—The approach of this low area was indicated by north Pacific coast reports of the 1st, and the morning of the 2d the center was located over or near Vancouver Island. At Tatoosh Island, Wash., the barometer fell to 29.32, with south winds and rain, and at Fort Canby, Wash., the wind reached a velocity of 61 miles per hour from the southeast. By the evening of the 2d the storm-center had advanced to Alberta, with a loss of energy. The rain area extended over the northern plateau

region, and the first snow of the season was reported at points in the Dakotas, and at Wichita, Kans. During the 3d the center of disturbance advanced to Manitoba, and thence to the Lake region during the 4th, where it dissipated, being bounded on the east by high area I, and on the west by high area III. On the 3d the first snow of the season was reported at points in Illinois, Indiana, Ohio, Kentucky, and at La Crosse, Wis., and on the 4th at Lansing, Mich., Sandusky, Ohio, and in western Pennsylvania and West Virginia.

III.—This low area followed closely after number II. Its presence off the north Pacific coast was indicated by reports of the 3d, and the morning of the 4th it was apparently central near the north part of Vancouver Island, whence it moved to Alberta by the evening of that date, with heavy rain on the north Pacific and north California coasts, and high southerly winds which reached 63 miles per hour at Fort Canby, Wash. During the 5th the center advanced to Manitoba. The morning of that date the pressure was below 29.50 in the Saskatchewan Valley, and the abnormal decrease of pressure in 12 hours was .42 at Prince Albert, N. W. T. Rain continued on the north Pacific coast, and wind velocities of 30 miles per hour and upward were noted in the Missouri and Red River of the North valleys. During the 6th the center moved slowly eastward over Manitoba, after which it apparently dissipated. The eastward advance of this low area, in conjunction with the influence of low area II by which it was immediately preceded, produced the highest temperatures of the month generally west of the Mississippi River, and at a number of stations in that region the maximum temperature was the highest ever reported for November.

IV and IV*a*.—Low area IV advanced from the north Pacific coast, and the evening of the 6th was central over Alberta, with central pressure below 29.50. On this date heavy rain fell on the north Pacific coast, and the wind reached a velocity of 54 miles per hour from the west at Fort Canby, Wash., and at Tatoosh Island, Wash., a thunderstorm, with heavy hail, occurred in the afternoon. During the 7th the center advanced to Manitoba, with a slight loss of energy by the evening of that date, and by the morning of the 8th it had united over Lake Michigan with IV*a*, which had advanced from the southwest. Low area IV*a* appeared central over Kansas the evening of the 6th, and passed thence to Lake Michigan by the 8th, with a moderate display of energy during the 7th, and after the union of the two areas the center moved northward and disappeared north of the Lake region. These two areas, with numbers II and III, contributed to produce the highest temperature of the month in the central valleys and the Lake region. No general rain attended low areas IV and IV*a* east of the Rocky Mountains, save in the upper lake region on the 7th and 8th. Thunderstorms were reported in northeastern Iowa on the 7th, and in northern Kentucky the early morning of the 8th.

V.—Appeared over central Texas the morning of the 8th, with pressure below 29.60, and heavy rain in eastern Texas, whence it moved to southern Arkansas by the evening of that date, with heavy rain in northern Louisiana and western Mississippi, and the first snow of the season in central New Mexico and western Texas. During the 9th the center passed to the lower Ohio valley, without an appreciable loss of energy; rain fell from the Lake region to the Gulf, the rainfall being heavy on the middle Gulf coast, and the wind reached a velocity of 48 miles per hour from the northwest at Corpus Christi, Tex. During the 10th the center of disturbance advanced to Michigan, with a marked increase of energy, a barometer reading of 29.32 and an abnormal decrease in pressure of .40 in 12 hours being noted at Alpena, Mich. The rain area extended to the Atlantic coast, and the wind exceeded 40 miles per hour over the west part of the lower lake region. By the morning of the 11th this low area had united with number VI, which had advanced from the Pacific coast. High temperature continued from the Lake region to Tennessee, attending the passage of this low area.

VI.—The presence of this low area on the Pacific coast north of the region of observation was shown by the evening reports of the 8th. On this date high southerly winds and heavy rain were reported in western Washington. By the morning of the 9th the center had advanced to Alberta, with pressure about 29.60, whence it moved to Assiniboia by the evening report, and to North Dakota by the 10th. On the latter-named date the central pressure fell below 29.50; the wind reached a velocity of 60 miles per hour from the northwest at Fort Assinaboine, Mont.; light rain fell in the Missouri Valley and snow over the middle plateau region and on the northeast slope of the Rocky Mountains. By the morning of the 11th the center had moved over the Lake region and united with low area V which had advanced from the southwest; the pressure had fallen below 29.30 over the north-central part of the Lake region; severe gales and heavy rain prevailed over the Lake region, and thence to the Missouri Valley; and the first snow of the season was noted at stations in the west part of the Lake region and in the upper Mississippi and middle Missouri valleys. On this date the rain area extended to the middle Atlantic and New England coasts. During the 12th the low area passed to the Gulf of Saint Lawrence with a marked decrease of energy. At points on the New England and middle Atlantic coasts the highest temperature of the month was reported from the 10th to 12th.

VII and VII*a*.—Low area VII apparently advanced from the British Northwest Territory, and the morning of the 15th was central over southern Manitoba as a slight depression. The evening report showed this low area central over upper Michigan, where it was joined by number VII*a* which had advanced from the southwest. On this date the abnormal decrease of pressure in 12 hours was .70 at Marquette, Mich.; the pressure fell below 29.70 at the center of the disturbance; fresh to strong gales prevailed over the Lake region; the rain area extended to western New York and western Pennsylvania; and snow fell over the northwest part of the Lake region and in the Red River of the North Valley. During the 16th the center moved slowly eastward north of the Lake region; the barometric gradient was marked to the eastward and westward; rain fell generally in the Atlantic coast states; and high winds continued over the Ohio Valley and the east part of the Lake region. By the evening of the 17th the center reached New Brunswick. On this date a marked increase of energy was shown; central pressure fell below 29.50; the wind reached a velocity of 54 miles per hour from the southwest at Buffalo, N. Y.; heavy wind and rain storms prevailed from the Lake region over New England; and the highest temperature of the month was reported at points in eastern New York and on the south New England coast. By the morning of the 18th the center had advanced over the Gulf of Saint Lawrence without an appreciable loss of energy. When this low area was central over Manitoba a trough of low pressure extended thence to Texas and two secondary low areas appeared, one over western Texas and the other, VII*a*, over eastern Kansas. The evening report of the 15th showed a low pressure trough from the west part of the Lake region to Texas, with one well-defined cyclonic center in upper Michigan.

VIII.—Appeared over Alberta the evening of the 17th, with central pressure about 29.80, an abnormal decrease in pressure of .54 in 12 hours being noted at Medicine Hat, N. W. T. On this date heavy rain fell on the north Pacific coast. During the 18th the center passed to Manitoba, with pressure below 29.60, and snow in the Saskatchewan Valley, and the night of the 19th it apparently disappeared by an increase of pressure north of the Lake region. On the latter-named date the first snow of the season was reported at Madison, Wis., and high southerly winds prevailed over the Lake region, a velocity of 51 miles per hour from the south being noted at Chicago, Ill.

IX.—Appeared over the British Northwest Territory on the 19th. The night of the 20th the center of disturbance moved over northeastern Montana, with pressure below 29.40, wind velocities exceeding 40 miles per hour from Washington over

Montana, and snow in the Saskatchewan Valley. During the 21st the low area advanced to the Lake Superior region, where it united with number IX*a* which had advanced from the southwest. The evening of this date a trough of low pressure extended from Lake Superior to Texas, with two cyclonic centers, one, number IX, over Lake Superior and the other, number X, over Indian Territory. Generally stormy weather prevailed east of the Rocky Mountains, high winds from the middle and northeast slopes of the Rocky Mountains eastward, and destructive gales over the Lake region. Low area IX*a* appeared near the Panhandle of Texas the morning of the 20th, whence it advanced northeastward and united with number IX by the evening of the 21st, its passage being attended by heavy rain in the central valleys during the 21st.

X.—Belongs to a type of winter storms which originate in the Southwest and move over the central valleys, gathering strength as they advance eastward. This low area was the first storm of this class of the season, and was notable chiefly on account of the rapid increase of energy during the 23d. For 24 hours preceding the appearance of this low area in the Southwest rain and strong southerly winds had been general throughout the central valleys and the Lake region. These conditions extended to the Atlantic coast during the 21st, and the birth of this storm in the southern part of a trough of low pressure which extended from the upper lake region to the Rio Grande Valley found the entire eastern country covered with a mass of warm, humid air walled in by high pressure to the eastward and westward. The barometric gradient was marked eastward to the Atlantic coast and westward to the plateau region, heavy rain fell in the central valleys and the Lake region, and the temperature was 10° to 20° above the normal from the Lake region and Saint Lawrence Valley to the middle and east Gulf coasts. West of the region of low pressure there was a decided fall in temperature, the abnormal change in 12 hours exceeding 30° in Colorado.

By the morning of the 22d the storm-center had moved east-northeast along the trough of low pressure which had shifted eastward, and occupied a circular area in the middle Mississippi valley bounded by the isobar of 29.70, and rain was falling generally east of the Rocky Mountains. By the evening of the 22d the center had changed its position but slightly, a marked decrease of pressure occurred, however, and the isobar of 29.60 included an area extending from Georgian Bay to the middle Mississippi valley. On this date the rainfall was excessive in the middle and east Gulf states and Tennessee, and the barometric gradient from the middle Mississippi valley to the middle Atlantic coast, a distance of about 900 miles, was .60 inch. Severe storms occurred in the Southern States; the temperature continued decidedly above the normal over the eastern part of the country; and there was a marked fall in temperature in the Southwest, the abnormal change in the 12 hours being more than 30° in Arkansas.

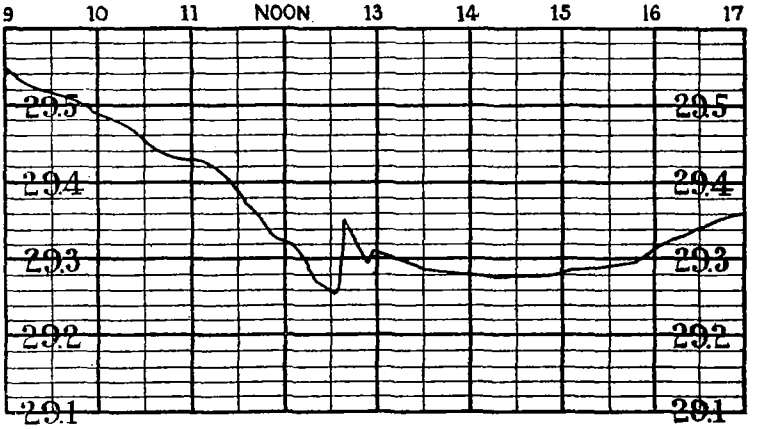
The general meteorological conditions at 8 a. m. and 8. p. m. (75th meridian time) of the 23d are shown on Chart VII. The morning of that date the center occupied central Ohio, with pressure 29.24 (reduced) at Cleveland and Columbus, Ohio; excessive rain fell in the Gulf States and Ohio Valley, and snow in Arkansas, Tennessee, and northern Mississippi. The line of freezing weather extended over Texas to the 30th parallel, and northward, west of the Mississippi River, to the west end of Lake Superior. The barometric gradient continued marked to the eastward and westward of the center. The evening report of the 23d locates the center near the west end of Lake Ontario, the lowest pressure, 28.86, being noted at Buffalo, N. Y. On this date there was a decrease of pressure of .38 at the storm-center and of .54 at Albany, N. Y., in 12 hours; high winds reaching 50 to 60 miles per hour, heavy rain, and storms of a local character occurred in the Atlantic coast states, the lower lake region, and the upper Ohio valley, causing considerable damage. At a number of points in the southeast quadrant of the cyclonic area the shift of wind from southeast to southwest was attended by heavy gusts or squalls of wind and rain, accompanied, in places, by thunder and lightning. In a number of instances the squalls advanced with a suddenness and velocity seldom witnessed in the middle-eastern states. Unfinished and insecure buildings were prostrated, causing some loss of life, and the aggregate loss was greatly swelled by damage of a minor character. During the night of the 23d–24th the center moved northeastward north of the Saint Lawrence River without an apparent loss of energy, and disappeared north of the Gulf of Saint Lawrence by the evening report of the 24th.

A resumé of the above description of this low area shows that its course and rate of advance were about normal; that a rapid increase of energy is not unusual in storms of the type to which it belongs; and that a general storm, the materials for which had been gathered prior to the development of this low area, extended over the region which it traversed. The trough of low pressure within which it originated presented in abundance the elements which contribute to a storm's growth and energy, and the increase in strength of the low area under consideration may be attributed to the favorable conditions which attended its origin, the elements of energy gathered and presented throughout its course, and the absence of areas of high pressure in the line of its direct and normal advance.

The severe wind and rain squalls which occurred over the Carolinas and the middle Atlantic states are given a description under the heading "Local storms." These storms, as stated above, occurred with the shift of wind from southeast to southwest, and generally marked the time of lowest pressure in the respective localities.

The following copy of a section of a barograph record presents the pressure curve at the Weather Bureau Office at Washington, D. C., from 9 hours to 17 hours of November 23, 1891. The barograph cylinder was about 4.9 minutes fast. Applying this correction, the true time of the upward turn was 12 hours, 28.7 minutes at its beginning, and 12 hours, 33.7 minutes at its maximum point. By another barograph these times are 12 hours, 30.4 minutes, and 12 hours, 35.1-5 minutes, respectively. It is thought that the latter figures are the more accurate, and the true time is assumed as 12 hours, 30 minutes, and 12 hours, 35 minutes, respectively.

Record of self-registering barometer, Washington, D. C., November 23, 1891 (in inches).



XI.—Appeared over the British Northwest Territory on the 24th, with pressure below 29.60, light rain on the north Pacific coast and over the northern plateau region, snow in the upper Missouri valley, and high winds on the northeast slope of the Rocky Mountains. During the 25th the center moved to Minnesota, with a slight increase in central pressure, a marked rise followed by a decided fall in temperature over North Dakota, and snow in the Lake region, the extreme upper Mississippi, and the Red River of the North valleys. On this date an ill-defined low area appeared over northern Texas, and a cyclonic disturbance was indicated over the eastern part of the Gulf of Mexico. On the 26th low area XI passed to Georgian Bay,

with pressure falling below 29.40, heavy gales over the Lake region, the wind reaching 50 miles per hour from the southwest at Chicago, Ill., rain in the southeastern and eastern states, and snow in the north and north-central districts. On this date fresh northerly winds and rain along the middle Atlantic and south New England coasts attended the presence of a low area off the Carolina coast. During the night of the 26–27th the center moved rapidly eastward and the morning of the 27th was central over eastern Maine, with central pressure below 29.30. On this date the greatest decrease in pressure in 12 hours noted for the month, .72, occurred at Eastport, Me.; snow fell in the northern part of the country east of the Rocky Mountains, rain in the middle and south Atlantic states, the Ohio and middle and lower Missouri valleys, and high winds prevailed from the eastern part of the Lake region to the New England coast. By the evening of the 27th the storm-center had disappeared over the Gulf of Saint Lawrence.

XII.—Advanced from the British Northwest Territory, and the morning of the 26th was central over Alberta, with pressure below 29.60. On this date the center advanced slowly southeastward, with a marked rise in temperature along the eastern slope of the Rocky Mountains, the abnormal rise in temperature in 12 hours being 24° at Pueblo, Colo., snow in the Missouri Valley, and high winds on the northeast slope of the Rocky Mountains. From this point the center of disturbance moved rapidly southeastward to the lower Missouri valley by the morning of the 27th, and thence north of east to Maine by the morning of the 28th, its average rate of advance, 54 miles per hour, being the greatest noted in connection with the low areas of the month. Slight changes occurred in central pressure during the passage of the low area. On the 27th the isobar of 29.70 inclosed an elongated area extending from the lower lake region west-southwestward over the Ohio Valley, with high pressure to the northwest and southeast, snow fell in the Lake region and middle Missouri valley, rain in the Ohio and upper Mississippi valleys, and fresh to high winds from the lower Missouri valley over the south part of the Lake region. During the 28th the storm-center disappeared in the direction of Newfoundland. On this date rain fell in the middle and south Atlantic states, snow from the Lake region over New York and New England, the first snow of the season at New York, Philadelphia, and at points in Maryland and Virginia, and fresh to high winds along the New England and middle Atlantic coasts.

On the 29th the first snow of the season fell at stations in Georgia, the Carolinas, and Virginia, attending the presence of a low area off the south Atlantic coast, and high winds exceeding 50 miles per hour occurred on the North Carolina and Virginia coasts. At Norfolk, Va., the depth of snowfall on this date exceeded 6 inches.

XIII.—Apparently advanced from the extreme north Pacific coast, and the evening of the 29th was central over the British Northwest Territory, with pressure 29.40 at Edmonton; and at Prince Albert, N. W. T., the decrease in pressure in 12 hours was .52. Over Manitoba the abnormal rise in temperature in 12 hours exceeded 20°, the wind reached a velocity of 60 miles per hour from the south at Fort Canby, Wash., and rain fell on the north Pacific coast. During the 30th the center moved slowly eastward over the Saskatchewan Valley, with a slight decrease in pressure, and rain fell from the middle and north Pacific coasts over the plateau region north of the 40th parallel.

Tabulated statement showing principal characteristics of areas of high and low pressure.

Barometer.	First observed.			Last observed.		Duration.	Velocity per hour.	Maximum pressure change and maximum abnormal temperature change in twelve hours and maximum wind velocity.								
	Date.	Lat. N.	Long. W.	Lat. N.	Long. W.			Station.	Rise.	Date.	Station.	Fall.	Date.	Station.	Direction.	Miles per hour.	Date.
High areas.		°	°	°	°	Days.	Miles.		Inch.								
I	1	48	101	46	65	3.5	25	White River, Ont.	.52	1	Cincinnati, Ohio	20	1	Battleford, N. W. T.	se.	32	1
II	3	41	112	34	105	1.5	17	Montrose, Colo.	.14	3	Tucson, Ariz.	17	5	Cheyenne, Wyo.	ne.	38	3
III	4	51	104	48	65	2.5	34	Prince Albert, N. W. T.	.28	4	Huron, S. Dak.	14	5	Pierre, S. Dak.	e.	20	5
IV	7	44	123	38	112	1.5	19	Rio Grande City, Tex.	.48	9	Abilene, Tex.	29	8	Eureka, Cal.	n.	22	7
V	9	43	126	43	69	6.0	24	Calgary, N. W. T.	.80	10	Miles City, Mont.	33	10	Valentine, Nebr.	w.	42	11
VI	15	53	114	40	71	4.5	27	Rockliffe, Ont.	.66	18	Fort Smith, Ark.	33	16	Bismarck, N. Dak.	nw.	42	16
VII	21	53	115	45	101	1.5	25	Medicine Hat, N. W. T.	.88	21	Pueblo, Colo.	36	21	do	nw.	38	22
VIII	27	47	101	37	81	3.0	22	Pierre, S. Dak.	.64	27	Wilmington, N. C.	37	29	Fort Sill, Okla. T.	n.	36	28
Mean						3.0	24		.55			27				34	
Low areas.									Fall.			Rise.					
I*	1	50	69	50	62	0.5	13	Sydney, C. B. I.	.30	1	Sydney, C. B. I.	7	1	Block Island, R. I.	nw.	36	1
II	2	50	128	48	85	2.5	33	Calgary, N. W. T.	.52	2	Medicine Hat, N. W. T.	24	2	Fort Canby, Wash.	se.	61	2
III	4	52	128	51	94	2.5	25	Prince Albert, N. W. T.	.42	5	Qu'Appelle, N. W. T.	23	4	do	s.	63	4
IV	6	53	113	43	87	1.5	38	Medicine Hat, N. W. T.	.26	6	Winnipeg, Man.	16	7	do	w.	54	6
IVa	6	38	98	47	85	1.5	19	Pueblo, Colo.	.22	5	Kansas City, Mo.	20	6	Cheyenne, Wyo.	w.	44	7
V	8	32	100	48	83	3.0	22	Alpena, Mich.	.40	10	Knoxville, Tenn.	18	9	Corpus Christi, Tex.	nw.	48	9
VI	9	52	112	49	64	3.5	29	Calgary, N. W. T.	.34	8	Pueblo, Colo.	22	10	Fort Assinaboine, Mont.	nw.	60	10
VII	15	49	98	50	63	3.0	25	Marquette, Mich.	.70	15	Chatham, N. B.	21	16	Buffalo, N. Y.	sw.	54	17
VIII	17	52	117	49	87	2.0	29	Medicine Hat, N. W. T.	.54	17	Fort Assinaboine, Mont.	27	18	Chicago, Ill.	s.	51	19
IX	20	52	110	48	86	1.5	36	Green Bay, Wis.	.52	21	Prince Arthur, Ont.	27	21	Fort Canby, Wash.	w.	50	20
														Denver, Colo.	nw.	50	21
IXa	20	37	103	48	86	1.5	36	Leavenworth, Kans.	.34	20	Fort Stanton, N. Mex.	16	19	Chicago, Ill.	sw.	48	21
														Detroit, Mich.	sw.	48	21
X	21	35	98	50	68	3.0	27	Albany, N. Y.	.54	23	Palestine, Tex.	16	21	Buffalo, N. Y.	sw.	66	24
XI	24	53	113	45	68	2.5	38	Eastport, Me.	.72	27	Bismarck, N. Dak.	24	25	Chicago, Ill.	sw.	50	26
XII	26	51	113	45	69	2.0	54	Qu'Appelle, N. W. T.	.44	26	Pueblo, Colo.	24	26	Fort Assinaboine, Mont.	w.	48	26
XIII	29	54	114	54	104	1.0	18	Prince Albert, N. W. T.	.52	30	Minnedosa, Man.	21	29	Fort Canby, Wash.	s.	60	29
Mean						2.1	29		.45			20				53	

*Continuation of low area X for October, 1891.

NORTH ATLANTIC STORMS FOR NOVEMBER, 1891 (pressure in inches and millimeters; wind-force by Beaufort scale).

The paths of storms that appeared over the west part of the north Atlantic Ocean during November, 1891, are shown on Chart I. These paths have been determined from observations by shipmasters received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

In November there is usually a decrease in mean pressure over the eastern part of the north Atlantic Ocean, the increase being most marked north of the British Isles, where the Iceland winter area of low pressure is forming. A decrease in pressure is also shown from this region westward to the Canadian Maritime Provinces. The region of greatest storm